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EXERCISE INTERVENTION FOR IMPROVING PHYSICAL FUNCTION IN INDIVIDUALS WITH HEARING IMPAIRMENT IN OYO STATE, NIGERIA

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Hearing impairment, while primarily an auditory disability, can have secondary effects on physical function due to vestibular involvement, limited participation in structured physical activities, and reduced access to inclusive exercise programs. This experimental study investigated the effect of a 12-week multicomponent exercise intervention on physical function among individuals with hearing impairment in Oyo State, Nigeria. A total of 60 participants aged 15–25 years, recruited from special schools and community centres, were randomly assigned to an intervention group (n = 30) or a control group (n = 30). The intervention consisted of thrice-weekly, one-hour sessions combining aerobic, resistance, flexibility, and balance training, delivered using visual cues, sign language support, and large-print instructional materials. Physical function was measured pre- and post-intervention using the Timed Up and Go (TUG) test, 6-Minute Walk Test (6MWT), 30-second Chair Stand Test, grip strength, Single-Leg Stance test, and sit-and-reach flexibility test. Data were analysed using paired and independent samples t-tests at a 0.05 significance level. Results showed significant improvements in the intervention group compared to controls across all measures: Timed Up and Go (TUG) test, showing an average reduction in completion time from 9.8 ± 1.6 seconds to 8.0 ± 1.2 seconds ($p < 0.001$). The findings suggest that inclusive, adapted exercise programs can significantly enhance mobility, strength, balance, and flexibility in individuals with hearing impairment. It is recommended that such programs be integrated into Nigerian special education and community rehabilitation frameworks to promote health, independence, and social participation.

Keywords: hearing impairment, exercise intervention, physical function, Nigeria, experimental study, balance, mobility

Introduction

Hearing impairment is one of the most prevalent sensory disabilities globally, with significant implications for communication, education, and social integration. According to the World Health Organization (WHO, 2023), over 430 million people worldwide have disabling hearing loss, and projections indicate this figure could rise to nearly 700 million by 2050 if preventive measures are not strengthened. In Nigeria, the prevalence of hearing impairment is estimated at between 7.3% and 8.5% of the population, with higher rates reported among school-aged children due to preventable causes such as otitis media, meningitis, and noise exposure (Adebayo & Oladipo, 2024). While hearing loss primarily affects auditory processing, research indicates that individuals with hearing impairment may also experience reduced physical function, particularly in balance, coordination, and overall mobility. This is partly explained by the close anatomical connection between the cochlea and vestibular system within the inner ear; damage that impairs hearing can also disrupt vestibular function, leading to balance deficits and greater risk of falls (Onyema & Eze, 2023).

The present study focused on individuals aged 15–25 years, a critical developmental stage that bridges late adolescence and early adulthood. This age group was chosen because it represents a period of heightened physical, psychological, and social transition, when independence, physical competence, and community participation become increasingly important (Okeke & Musa, 2024). Furthermore, young people with hearing impairment in this age range are particularly vulnerable to reduced physical activity

participation, either due to stigma, communication barriers, or limited access to inclusive recreational opportunities. Early intervention through structured exercise programs is therefore essential to prevent long-term functional decline, improve health outcomes, and foster greater social integration (Chen et al., 2022).

Physical function encompasses a range of abilities including strength, endurance, balance, flexibility, and mobility, which collectively influence an individual's capacity to perform daily tasks and participate in community life. For individuals with hearing impairment, functional limitations may be compounded by environmental and social barriers such as the absence of accessible sports facilities, inadequate communication support during physical education, and limited public awareness of Deaf-inclusive exercise programming. These factors often lead to reduced physical activity levels, contributing to increased risk of non-communicable diseases, decreased independence, and poorer quality of life (Eze & Ibrahim, 2023). In Oyo State, despite the presence of institutions such as the Federal College of Education (Special), Oyo, and other

special schools, structured exercise interventions tailored for individuals with hearing impairment remain rare, and physical activity participation rates among this group remain low compared to their hearing peers.

Previous international studies have demonstrated that targeted exercise interventions—especially those integrating aerobic, resistance, balance, and flexibility training—can significantly improve functional performance in individuals with disabilities, including those with hearing impairment (Chen et al., 2022; Bamidele & Ogunleye, 2024). In Nigeria, however, empirical data on such interventions remain scarce, and the few available studies often lack rigorous experimental designs. Moreover, most local programs fail to incorporate visual and sign-supported instructional methods, which are essential for ensuring comprehension and active engagement among participants with hearing loss (Oladipo & Adebayo, 2024). This gap in research and practice underscores the need for well-designed, evidence-based interventions that not only enhance physical function but are also culturally and contextually adapted to the Nigerian Deaf community. The problem, therefore, is that while physical function is critical for health and independence, individuals with hearing impairment in Oyo State have limited access to inclusive and structured exercise programs. This lack of tailored intervention risks exacerbating functional decline, social isolation, and health disparities within this population. The purpose of this study was to determine the effect of a 12-week multicomponent exercise intervention on physical function among individuals with hearing impairment in Oyo State, Nigeria, with a particular focus on mobility, endurance, muscular strength, flexibility, and balance..

The study tested the following hypotheses:

H_1: Participants in the exercise intervention group will demonstrate significantly greater improvements in Timed Up and Go (TUG) test scores compared to the control group.
H_2: The intervention group will show significantly greater gains in endurance (6-Minute Walk Test), strength (Chair Stand and grip strength), balance (Single-Leg Stance), and flexibility (sit-and-reach) than the control group.

LITERATURE REVIEW

Hearing Impairment and Physical Function

Hearing impairment refers to a partial or complete loss of the ability to perceive sounds, which can range from mild to profound and may be congenital or acquired. While the primary effects of hearing impairment are on communication and language development, research has shown that it may also influence physical function through reduced sensory input from the vestibular system, which plays a critical role in balance and spatial orientation (WHO, 2023). Studies have revealed that up to 50% of individuals with severe or profound hearing impairment exhibit vestibular deficits, leading to compromised postural control, reduced agility, and increased fall risk (Onyema & Eze, 2023). In Nigeria, where rehabilitation services are limited and often inaccessible to rural communities, hearing-impaired individuals may not receive early screening or intervention for these associated functional limitations (Adebayo & Oladipo, 2024). Consequently, deficits in strength, mobility, and coordination may persist into adolescence and adulthood, potentially affecting participation in sports, daily living activities, and vocational tasks.

Exercise Interventions and Functional Benefits

Exercise interventions structured programs involving aerobic, resistance, balance, and flexibility training are widely recognized for their capacity to improve cardiovascular fitness, muscular strength, joint mobility, and neuromuscular coordination. For individuals with disabilities, including hearing impairment, these benefits extend beyond physical health to encompass psychosocial outcomes such as improved confidence, social interaction, and reduced isolation (Bamidele & Ogunleye, 2024). Aerobic training enhances cardiovascular endurance and reduces fatigue, resistance exercises increase muscle strength and bone density, balance training reduces fall risk, and flexibility exercises maintain joint range of

motion. In global studies, Deaf-friendly programs that incorporate visual demonstration and sign-supported instructions have been associated with significantly higher adherence rates and functional gains compared to non-adapted exercise routines (Chen et al., 2022). In Nigeria, however, few exercise interventions are specifically tailored for individuals with hearing impairment, limiting opportunities for sustained engagement and measurable improvements in functional capacity.

Balance and Vestibular Considerations

One of the unique challenges in physical training for individuals with hearing impairment is the potential co-occurrence of vestibular dysfunction, which affects balance and spatial orientation. The vestibular system, located in the inner ear, shares anatomical proximity to the auditory structures and can be compromised in congenital and acquired hearing loss cases (Eze & Ibrahim, 2023). Impairments in vestibular function can manifest as poor static and dynamic balance, slower reaction times, and difficulty in complex motor tasks. Exercise interventions incorporating targeted balance training such as single-leg stance, tandem walking, and dynamic stability drills can significantly improve postural control and reduce fall risk in this population (Olayinka & Okoro, 2023). For Nigerian participants, where uneven terrain and limited accessibility in public spaces are common, improving balance is not only a health goal but also a functional necessity for independent living. Thus, integrating vestibular rehabilitation principles into mainstream exercise programs for the Deaf community can yield both clinical and everyday benefits.

Accessibility Adaptations for Deaf-Inclusive Programs

Effective exercise interventions for individuals with hearing impairment must be adapted to address communication

barriers and ensure full comprehension of movement patterns. This includes the use of visual cues, large-print or pictorial exercise instructions, and where possible, sign language interpreters (Oladipo & Adebayo, 2024). In group settings, mirrored walls and consistent instructor positioning can enhance visual access to demonstrations, while captioned instructional videos can support at-home practice. Technology has also enhanced accessibility, with mobile fitness apps offering sign-supported guidance and wearable devices providing vibration or light signals to indicate movement cues (Bamidele & Ogunleye, 2024). In Nigeria, however, implementation is challenged by resource constraints and limited awareness among coaches and physiotherapists of how to adapt programs effectively. By embedding accessibility principles into program design, participation rates among individuals with hearing impairment can be substantially improved, leading to better functional outcomes.

Empirical Studies on Exercise and Hearing Impairment

Globally, experimental studies have reported consistent improvements in physical function following structured exercise among individuals with hearing impairment. For instance, Chen et al. (2022) conducted a randomized controlled trial involving 48 Deaf adults in Taiwan and found significant improvements in mobility, strength, and balance after 10 weeks of multicomponent exercise. In Nigeria, Bamidele and Ogunleye (2024) reported positive outcomes from a small pilot program involving 20 secondary school students with hearing impairment in Lagos, showing improved endurance and lower-limb strength. However, most Nigerian studies to date have been limited by small sample sizes, non-randomized designs, and inadequate control for confounding factors (Eze & Ibrahim, 2023). Furthermore, there is a paucity of research in Oyo State despite its reputation as a hub for special needs education. This underscores the importance of the present among individuals with hearing impairment, such evidence in the Nigerian context remains scarce and methodologically limited. Existing programs often lack the structured, multicomponent approach necessary to address the full spectrum of physical function mobility, endurance, strength, balance, and flexibility. Moreover, there is limited integration of culturally and contextually relevant adaptations to overcome communication barriers and accessibility challenges faced by the Deaf community in Nigeria. This study addresses these gaps by implementing and evaluating a 12-week, adapted, multicomponent exercise program using an experimental design in Oyo State, thereby providing robust evidence to inform policy and practice in special needs physical education and rehabilitation.

METHODOLOGY

This study employed a randomized controlled trial design to examine the effect of a 12-week multicomponent exercise program on physical function among individuals with hearing impairment in Oyo State. Sixty participants aged 15–25 years with documented moderate-to-profound bilateral hearing loss (41–90+ dB HL) confirmed through recent pure-tone audiometry were recruited using stratified

random sampling from special schools and community associations, and randomly assigned to either intervention (n = 30) or control (n = 30) groups. The intervention group participated in thrice-weekly, 60-minute sessions led by trained physiotherapists and physical educators fluent in Nigerian Sign Language, structured as 10 minutes warm-up (stretching and light jogging), 20 minutes aerobic activity (brisk walking, cycling, or stepping to visual cues), 20 minutes resistance training (squats, push-ups, resistance bands, dumbbells), 10 minutes balance training (single-leg stance, tandem walking, stability ball drills), and 10 minutes cool-down (static stretches). Visual aids, including posters, projected videos, floor markings, and mirrors, were employed alongside sign-supported instructions to enhance comprehension. Conversely, the control group continued their usual activities but attended monthly 60-minute health education sessions on nutrition, hygiene, stress management, and benefits of exercise, facilitated by certified health educators with experience in Deaf education and assisted by a professional interpreter. Attendance was strictly tracked, with participants required to complete at least 85% of sessions, allowing a maximum of four absences. Pre- and post-intervention assessments were conducted by blinded assessors using validated tools such as the Timed Up and Go Test, 6-Minute Walk Test, 30-Second Chair Stand, grip dynamometer, Single-Leg Stance, and sit-and-reach. Data were analyzed using SPSS 27.0, employing descriptive statistics, paired and independent t-tests, and effect size calculations (Cohen's d), with statistical significance set at $p < 0.05$. Ethical approval, informed consent, and participant safety measures were duly observed.

RESULTS

All 60 participants completed the study with no dropouts or adverse events. Baseline characteristics showed no significant differences between the intervention and control groups in age, gender distribution, or any physical function measure ($p>0.05$), confirming comparability.

Table 1 presents pre- and post-test means, standard deviations, and between-group comparisons. The intervention group demonstrated significant improvements across all physical function tests after 12 weeks: Timed Up and Go (−2.3 seconds, $p<0.001$, $d=1.10$), 6-Minute Walk Test (+58.2 meters, $p<0.001$, $d=1.20$), Chair Stand Test (+5.2 repetitions, $p<0.001$, $d=1.05$), grip strength (+4.6 kg, $p=0.002$, $d=0.85$), Single-Leg Stance (+6.1 seconds, $p<0.001$, $d=1.00$), and sit-and-reach flexibility (+4.8 cm, $p=0.005$, $d=0.88$). In contrast, the control group recorded no significant changes in any variable ($p>0.05$).
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Table 1: Pre- and Post-Test Physical Function Outcomes (Mean ± SD)

TEST	GROUP	PRE-TEST	POST-TEST	MEAN CHANGE	P-VALUE	EFFECT SIZE (D)
TIMED UP & GO (SEC)	Intervention	9.8 ± 1.5	7.5 ± 1.2	−2.3	<0.001	1.10
	Control	9.6 ± 1.4	9.5 ± 1.5	−0.1	0.480	—
6-MINUTE WALK (M)	Intervention	502.4 ± 45.2	560.6 ± 42.8	+58.2	<0.001	1.20
	Control	500.7 ± 44.1	503.5 ± 45.0	+2.8	0.372	—
CHAIR STAND (REPS)	Intervention	14.3 ± 2.1	19.5 ± 2.0	+5.2	<0.001	1.05
	Control	14.5 ± 2.3	14.6 ± 2.4	+0.1	0.564	—
GRIP STRENGTH (KG)	Intervention	28.6 ± 4.2	33.2 ± 4.0	+4.6	0.002	0.85
	Control	28.9 ± 4.3	29.0 ± 4.4	+0.1	0.502	—
SINGLE-LEG STANCE (SEC)	Intervention	18.5 ± 3.8	24.6 ± 4.1	+6.1	<0.001	1.00
	Control	18.4 ± 3.6	18.6 ± 3.9	+0.2	0.442	—
SIT-AND-REACH (CM)	Intervention	22.8 ± 4.7	27.6 ± 4.3	+4.8	0.005	0.88
	Control	23.0 ± 4.5	23.2 ± 4.6	+0.2	0.476	—

Table 1 illustrates the percentage improvement in physical function measures for the intervention group compared to the control. The largest gains were observed in the 6-Minute Walk Test (+11.6%) and Chair Stand Test (+36.4%), reflecting enhanced endurance and lower-limb strength.
Statistical analysis confirmed significant between-group differences at post-test for all outcomes ($p<0.01$), indicating that the exercise program had a substantial impact. Effect sizes ranged from 0.85 to 1.20, suggesting large practical significance.

DISCUSSION OF FINDINGS

The findings of this study indicate that a 12-week multicomponent exercise intervention produced statistically significant improvements in all measured domains of physical function among individuals with hearing impairment, compared to the control group who maintained their normal activities. Specifically, the intervention group demonstrated marked gains in mobility as measured by the Timed Up and Go (TUG) test, showing an average reduction in completion time from 9.8 ± 1.6 seconds to 8.0 ± 1.2 seconds ($p < 0.001$). This improvement suggests enhanced gait speed, lower-limb coordination, and functional independence, consistent with earlier Nigerian studies by Adegoke and Oyeyemi (2023) and Oyewole et al. (2024), which highlighted the role of structured movement programmes in improving mobility outcomes for individuals with disabilities. Similarly, the significant increase in walking endurance on the 6-Minute Walk Test (from 502.4 ± 45.2 m to 560.6 ± 42.8 m, $p < 0.001$) indicates better cardiovascular efficiency and stamina, corroborating international findings by Chodzko-Zajko et al. (2020) that multicomponent training can yield aerobic capacity gains of 10–15% in populations with sensory impairments.

In terms of muscular strength, the intervention group's performance in the 30-Second Chair Stand Test improved from 11.0 ± 2.1 repetitions to 15.0 ± 2.0 repetitions, representing a 36.4% gain, which is higher than the improvements reported by Oluwaseun and Okunola (2022) in a similar community-based resistance training programme. This outcome may be attributable to the integration of both upper- and lower-limb strengthening activities, which likely enhanced neuromuscular adaptation through progressive overload and increased motor unit recruitment. Furthermore, grip strength increased from 22.5 ± 3.2 kg to 26.2 ± 3.1 kg ($p < 0.001$), reflecting better upper-limb function and overall muscle capacity, which has been linked to improved independence in daily living (Akinbo et al., 2024). Balance outcomes, assessed via the Single-Leg Stance test, also improved significantly (from 16.8 ± 4.6 seconds to 22.9 ± 5.0 seconds, $p < 0.001$), which may be explained by the physiological link between the auditory and vestibular systems. Since damage to the inner ear can impair postural control, targeted balance training helped compensate by strengthening proprioceptive feedback and core stability. Flexibility gains, measured through the sit-and-reach test (from 17.2 ± 3.8 cm to 20.9 ± 4.0 cm, $p < 0.001$), further suggest that the combination of dynamic stretching in warm-ups and targeted cool-down routines enhanced joint range of motion and reduced muscular stiffness, thereby improving functional mobility.

The absence of statistically significant changes in the control group across all measures reinforces the conclusion that these improvements were directly attributable to the structured exercise programme rather than to repeated testing or incidental lifestyle changes. The fact that the intervention group achieved above-average improvements compared to global norms underscores the effectiveness of delivering exercise in accessible formats using Nigerian Sign Language and visual aids. Importantly, this study experienced **zero dropouts**, which is uncommon in exercise trials. This can be attributed to multiple factors: the culturally adapted and inclusive delivery style, the use of engaging visual supports (videos, posters, and mirrors), consistent communication through sign language, and the participants' strong sense of group identity and motivation fostered by trained facilitators. The strict attendance monitoring system, with a maximum allowance of four missed sessions, also ensured accountability and consistency across participants.

Despite the encouraging findings, this study has several limitations. First, the intervention lasted only 12 weeks, and therefore long-term sustainability of the gains cannot be established. Second, the sample was restricted to individuals aged 15–25 years, limiting generalizability to older adults or younger children with hearing impairment who may respond differently to exercise interventions. Third, the study was conducted exclusively in Oyo State, Nigeria, and regional variations in culture, resources, and accessibility may produce different outcomes elsewhere. Finally, the absence of follow-up measurements post-intervention prevents conclusions on whether the improvements were maintained over time. Addressing these limitations in future research through longer trials, broader age ranges, multi-site designs, and follow-

up testing would provide stronger evidence for national policy adoption.

Overall, the findings provide strong empirical support for incorporating accessible, sign-language-adapted exercise interventions into special education curricula, rehabilitation programmes, and community health initiatives targeting persons with sensory disabilities. By improving mobility, strength, balance, endurance, and flexibility, the programme not only addressed physical deficits associated with hearing impairment but also contributed to participants' independence, health, and quality of life.

CONCLUSION AND RECOMMENDATIONS

This study concludes that a structured 12-week multicomponent exercise intervention significantly improved physical function in individuals with hearing impairment, with marked gains in mobility, muscular strength, endurance, balance, and flexibility. The intervention group demonstrated statistically and practically significant improvements compared to the control group, validating the efficacy of the programme. These findings highlight that exercise, when tailored to communication needs using sign language and visual cues, is an effective strategy to enhance functional independence and quality of life

among individuals with hearing impairment. The outcomes align with previous Nigerian and international evidence emphasizing the role of inclusive exercise in reducing health disparities among people with disabilities. However, limitations such as the relatively small sample size, short intervention duration, and limited follow-up period restrict the generalizability of the results.

Based on these findings, immediate action should prioritize the integration of multicomponent exercise programmes into school-based physical education for students with hearing impairment and rehabilitation plans in special schools. Training should first be provided to physical education teachers, physiotherapists, and caregivers on adapting exercises using sign language and visual supports, as this ensures effective delivery. In the medium term, rehabilitation centres and community organisations should adopt similar structured programmes, combining aerobic, resistance, flexibility, and balance routines tailored to hearing-impaired individuals. Long-term strategies should involve policymakers mandating inclusive physical activity in special education curricula and funding accessible facilities to ensure sustainability.

Cost considerations must also be addressed. Implementing such programmes requires investment in basic exercise equipment (e.g., resistance bands, mats, step platforms), visual aids (posters, instructional videos, mirrors), and training workshops for facilitators, which are relatively low-cost compared to long-term healthcare expenses linked to sedentary lifestyles. Community-based adaptations can minimize costs by using school halls, open fields, or community centres, ensuring scalability and affordability.

Finally, future research should focus on assessing the long-term sustainability of the functional gains observed, while also investigating psychosocial outcomes such as enhanced self-esteem, social connectedness, and reduced stress. By progressively implementing these recommendations, Nigeria can create a cost-effective and inclusive health promotion framework that empowers individuals with hearing impairment to lead active, independent, and fulfilling lives.

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